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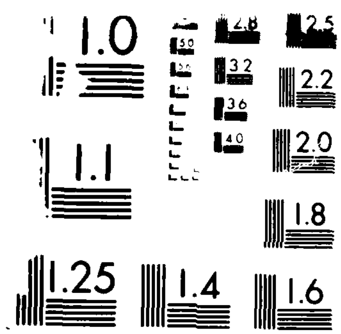
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LABORATORY NOTE NO. 87-64

CHANGES IN PHYSIOLOGIC VARIABLES IN RESPONSE TO PHYSICAL RESTRAINT DURING HEMORRHAGE IN CONSCIOUS SWINE

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ABSTRACT

Responses to hemorrhage (38.5 ml/kg/60 min) were evaluated in chronically catheterized conscious pigs (20-25 kg) restrained in a portable holding cage (n=6), a squeeze cage (n=8), or a Pavlov sling (n=8). Before hemmorrhage, heart rates of squeeze cage animals (145±4 b/m, x±SEM) and sling animals (129±9 b/m) were significantly higher ($p<0.05$) than heart rates of holding cage pigs (107±5 b/m). Hemorrhage caused a further increase in heart rate (216±15 b/m) in sling animals, but not in holding cage animals (104±7 b/m) or squeeze cage animals (157±20 b/m). Initially animals in the squeeze cage had a mean arterial pressure (99±4 mmHg), lower than in the holding cage animals (105±2 mmHg). However, these differences were not significant. Following hemorrhage, mean arterial pressures were similar in holding cage (46±4 mmHg) and squeeze cage animals (43±4 mmHg) while the mean arterial pressure in sling animals was elevated (58±8 mmHg). There were no differences in hematocrit values between groups either before or after hemorrhage. Plasma glucose and lactate levels were lower in sling animals before hemorrhage (82±4 mg/dl and 8.1±0.05 mg/dl) and after hemorrhage (161±31 mg/dl and 85.2±6.9 mg/dl) than in holding cage animals. Arterial PO_2 values were elevated in squeeze cage and sling animals throughout the experiment compared to holding cage animals. Also their PCO_2 values were lower than the holding cage animals. The evidence suggest that cardiovascular and metabolic responses are altered qualitatively and quantitatively by method of restraint during hemorrhage in conscious swine.

ABSTRACT

Responses to hemorrhage (38.5 ml/kg/60 min) were evaluated in chronically catheterized conscious pigs (20-25 kg) restrained in a portable holding cage (n=6), a squeeze cage (n=8), or a Pavlov sling (n=8). Before hemmorrhage, heart rates of squeeze cage animals (145±4 b/m, x±SEM) and sling animals (129±9 b/m) were significantly higher ($p<0.05$) than heart rates of holding cage pigs (107±5 b/m). Hemorrhage caused a further increase in heart rate (216±15 b/m) in sling animals, but not in holding cage animals (104±7 b/m) or squeeze cage animals (157±20 b/m). Initially animals in the squeeze cage had a mean arterial pressure (99±4 mmHg), lower than in the holding cage animals (105±2 mmHg). However, these differences were not significant. Following hemorrhage, mean arterial pressures were similar in holding cage (46±4 mmHg) and squeeze cage animals (43±4 mmHg) while the mean arterial pressure in sling animals was elevated (58±8 mmHg). There were no differences in hematocrit values between groups either before or after hemorrhage. Plasma glucose and lactate levels were lower in sling animals before hemorrhage (82±4 mg/dl and 8.1±0.05 mg/dl) and after hemorrhage (161±31 mg/dl and 85.2±6.9 mg/dl) then in holding cage animals. Arterial PO_2 values were elevated in squeeze cage and sling animals throughout the experiment compared to holding cage animals. Also their PCO_2 values were lower than the holding cage animals. The evidence suggest that cardiovascular and metabolic responses are altered qualitatively and quantitatively by method of restraint during hemorrhage in conscious swine.

CHANGES IN PHYSIOLOGIC VARIABLES IN RESPONSE TO PHYSICAL RESTRAINT DURING HEMORRHAGE IN CONSCIOUS SWINE

Responses of cardiovascular, endocrinological, and biochemical variables may be altered both quantitatively and qualitatively by different methods of handling swine (1-3). The physiologic responses to hemorrhage were assessed in conscious swine restrained by three methods. the evidence shows that the responses varied in the three groups.

MATERIALS AND METHODS

Twenty-two immature Yorkshire swine, body weight 20-25 kg, were studied. The animals were prepared surgically with a carotid artery catheter (1) or an aortic side port catheter (4). The pigs were allowed 5 to 7 days to recover from the operation. Before the experiment, animals were fasted overnight and moved to the laboratory in portable transfer cages. The animals were divided into three groups:

Group I. Restrained in a portable holding cage (105x60x75 cm), n=6.

Group II. Restrained in a squeeze cage (105x30x75 cm), n=8.

Group III. Restrained in a modified Pavlov sling, n=8.

Heart rate and mean arterial pressure were measured by a cardiovascular monitoring system (5) comprised of an arterial catheter connected to a 1 ft (30.5 cm) pressure monitoring/injection line. The line was fitted with a three-way plastic stopcock and filled with heparinized saline (500 units/ml). Residual blood and heparinized saline were then aspirated from the catheter and the entire system was filled with fresh heparinized saline (10 units/ml). Thereafter, the stopcock was connected to the monitoring/injection line, filled with heparinized saline and connected to a Statham P23Db pressure transducer. The transducer was mounted to a ring stand positioned at the level of the animal's heart.

Heart rate, mean arterial pressure, and pulse pressure were measured by Gould 2200S recorder before and after hemorrhage. Over a period of 60 minutes the pigs were hemorrhaged 50 percent of their total blood volume (38.5 ml/kg) as estimated by the vonEngelhardt regression equation (2). Blood samples were drawn before and after hemorrhage for analysis by a ILS System 1303 pH/blood gas analyzer, and hematocrit determined with a Clay-Adams microhematocrit centrifuge. Additionally, plasma glucose levels were determined by the Smith-Kline Spichem reagent method and plasma lactate according the method described in Sigma Technical Bulletin No. 7261-UV. Difference between groups of animals were determined by using a two-way ANOVA and Newman-Keuls test. Significance was determined at $P< 0.05$, and values shown as mean $\pm$SEM.

RESULTS

Before hemorrhage the mean heart rate of squeeze cage (Group II) animals was 145$\pm$4 b/m($\bar{x}\pm$SEM for all values), and sling (Group III) was 129$\pm$9 b/m. The control (Group I) animals had a mean heart rate of 107$\pm$5 b/m (Figure 1). After hemorrhage, the mean heart rate of Group III animals was increased to 216$\pm$15 b/m. In response to hemorrhage, animals in Groups I and II showed no change in heart rate. Immediately before hemorrhage, animals in the squeeze cage (Group II) had a mean arterial pressure of 99$\pm$4 mmHg, and holding cage (Group I) animals had a mean arterial pressure of 105$\pm$2 mmHg. The mean arterial pressure of Group III animals was elevated to 111$\pm$7 mmHg, an increase of approximately 6 percent. These values were not significantly different (Figure 1). After hemorrhage, the mean arterial pressure of all groups declined.

Before hemorrhage, the mean pulse pressure of control (GroupI) animals was 42$\pm$2 mmHg while the mean pulse pressure of Group II was 53$\pm$5 mmHg, and Group III was 59$\pm$4 mmHg. After hemorrhage, the mean pulse pressure of Group III animals in the Pavlov sling was 39$\pm$7 mmHg (33 percent less than the mean pulse pressure of control animals).

There were no differences in hematocrits between groups of animals either before or after hemorrhage (Figure 2). Before hemorrhage, the mean plasma glucose levels were lower in both Group II (74$\pm$12 mg/dl) and Group III (82$\pm$4 mg/dl) than in control (Group I) animals, (87$\pm$3 mg/dl).

The squeeze cage (Group II) animals had a mean plasma glucose level significantly lower than control animals (Figure 2).

Before hemorrhage, the mean lactate level in Group III animals was 8.1±0.5 mg/dl, and significantly lower than control (Group I) animals (10.2±1.1 mg/dl). After hemorrhage the mean lactate levels were elevated in all groups. The mean lactate level in sling animals was significantly lower than control animals (Figure 2).

The arterial pH between groups of animals before and after hemorrhage showed no significant change (Figure 3).

Before hemorrhage, the mean arterial PO2 values were elevated significantly in Group I animals (94.5±3.5 torr) and Group II animals (92.9±3.1 torr). After hemorrhage, the mean arterial PO_2 values were once again elevated significantly in Group I animals (126.5±6.0 torr) and Group II animals (115±6.0 torr), (Figure 3).

Before hemorrhage, the mean arterial PCO_2 values were reduced in squeeze cage (37.1±0.9 torr) and sling animals (38.3±0.8 torr) compared to control animals (41.0±1.1 torr). This reduction was significant in squeeze cage (Group II) animals. After hemorrhage, the mean arterial PCO_2 values were reduced in all groups. However, these values were lower in squeeze cage (Group II) animals (26.7±1.4 torr) compared to control (Group I) animals (28.4±1.9 torr), (Figure 3).

COMMENT

Studies indicate that physiologic responses, e.g.,cardiovascular, biochemical, and endocrinologic can be altered by handling and restraint of laboratory animals (1-3,5). Hannon (1) showed that swine resting in a recumbent positon for 30 minutes have relatively stable vital signs. VonEngelhardt (2) and Wade, et al (3) showed that animals excited by handling have variable heart rates, blood pressures and catecholamine levels. Our study assessed the changes in physiologic responses produced by different environmental factors and in response to hemorrhage in three groups of conscious swine, i.e., a holding cage that allowed the swine to assume a recumbent position (Group I); a squeeze cage that allowed the pig to lay down but not move about (Group II); a modified Pavlov sling that

completely restrained the animal (Group III). An evaluation of the data suggests that all physiologic responses were consistent with results from similar studies (1-3,5). In most instances the greater the degree of restraint (modified Pavlov sling >squeeze cage >holding cage) the greater the variability in the measured variables and in the response to hemorrhage.

CONCLUSION

Cardiovascular and metabolic responses are altered qualitatively and quantitatively by the method of restraint during hemorrhage in conscious swine.

RECOMMENDATION

Our findings suggest that it is important to evaluate the physiologic responses of swine in different types of restraint before gathering data on cardiovascular and metabolic responses.

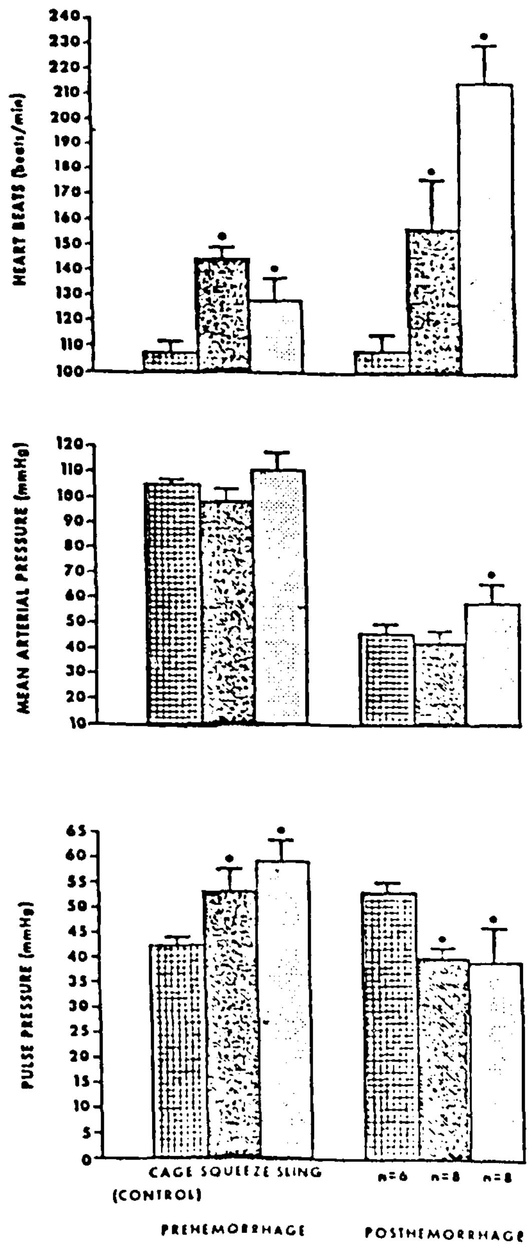

FIGURE 1: Heart rate (beats/min), mean arterial pressure (mmHg), and pulse pressure (mmHg) of holding cage (control) animals (n=6), squeeze cage animals (n=8), and sling animals (n=8), before and after hemorrhage. (*) indicates significant difference between groups of animals as compared to control animals. Note, (*) does not indicate significance across groups of animals, i.e., groups of animals before hemorrhage are not compared to groups of animals after hemorrhage.

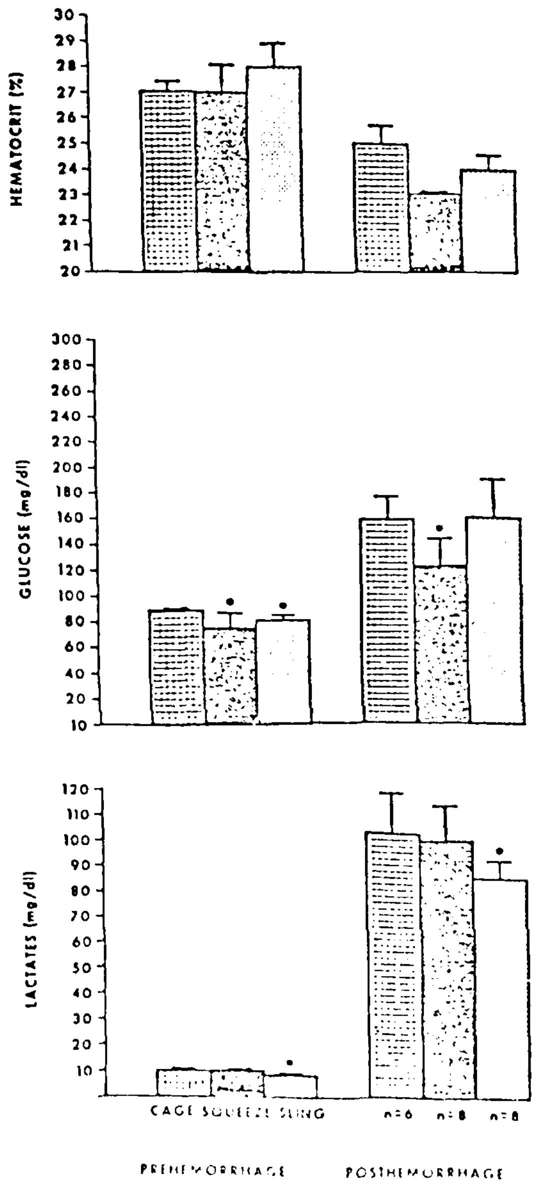

Figure 2: Hematocrit (%), glucose (mg/dl), and lactate (mg/dl) for holding cage (control) animals, squeeze cage animals, and sling animals before and after hemorrhage. (*) indicates significant difference between groups of animals as compared to control animals. Note, (*) does not indicate significance across groups of animals, i.e., groups of animals before hemorrhage are not compared to groups of animals after hemorrhage.

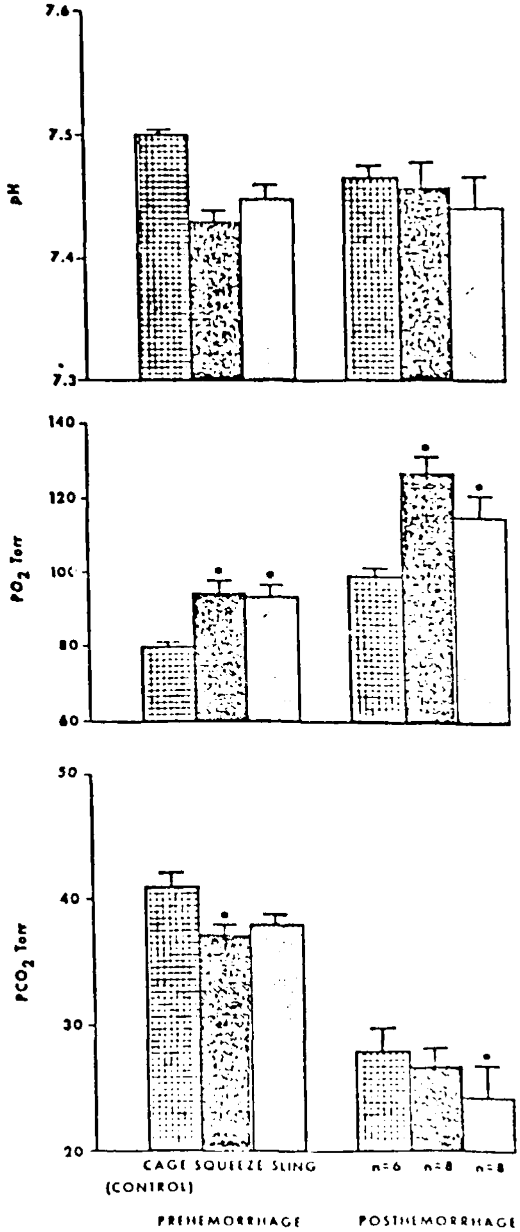

Figure 3: The pH, PO^2 (torr), and PCO^2 (torr) of holding cage animals, squeeze cage animals, and sling animals before and after hemorrhage. (*) indicates significant difference between groups of animals as compared to control animals. Note, (*) does not indicate significance across groups of animals, i.e., groups of animals before hemorrhage are not compared to groups of animals after hemorrhage.

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